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Global Imaging introduced an interactive image processing system in 1985, featuring the Global Applications Executive (GAE) which is a modified TAE environment. The executive plus a large variety of image processing functions, known commercially as the System 9000, are designed to operate on the Hewlett-Packard family of Unix computers. Beacause the US Navy has chosen the Hewlett-Packard as its standard desktop computer (NSDTC), the System 9000 has found easy acceptance for naval image processing applications. In 1986, Global has installed its systems at the US Naval Academy, the Naval Research Laboratory and the Naval Oceanographic Facility. Other naval installations are currently considering acquisition of this capability.

The Department of Oceanography at the Naval Academy, Annapolis, Maryland, has installed an NSDTC with an image processing upgrade provided by Global Imaging. This interactive digital image processing workstation is used by the midshipmen and staff for training and research in remote sensing oceanography. The turn-key system provides the capability to process imagery from commonly used earth observation spacecraft, in conjunction with in situ data sets. This marks the first time an undergraduate oceanographic curriculum offers such an advanced capability.

The Acoustics Group at the Naval Research Laboratory, Washington, DC has acquired its first System 9000 to interactively process ocean acoustic data gathered by shipboard sensors. The vertical acoustic profiles had been processed up to now by a laborious batch process. The ease of user interaction will permit faster analysis of the raw data.

Several naval installations are currently working on the Tactical Environmental Support System (TESS). This shipboard computer system is tasked with consolidating oceanic and atmospheric information to aid tactical decisions. The first and second generations of TESS are based on the NSDTC hardware, while the third generation hardware is still under consideration. The Naval Oceanographic Facility in Bay St. Louis, Mississipi has recently acquired a System 9000 to provide a TESS 2 prototype with image processing capabilities. This will permit merging of conventional data with polar orbiting spacecraft imagery.

Global Imaging is proposing to utilize GAE as the user interface for the third generation of TESS. In this system, each shipboard computer requires five workstations, four of which must be capable of interactive image processing. The imagery will be acquired in real-time from the NOAA, DMSP and NROSS polar orbiting satellites. In addition, a vast array of climatological, geophysical and recent environmental data must be analyzed to provide tactical decision aids for ship and aircraft operations at sea. This complex processing environment can be greatly simplified by providing the operators with the tutor, menu and help features of GAE.

Hardware

The current System 9000 is based on the Hewlett-Packard Series 300 and 500 high-performance 32-bit processor (CPU), with a direct address range of 500 Megabytes. A separate input/output processor (IOP) frees the CPU from functions associated with direct memory access by peripherals such as disk drives and displays. The modular design of this computer permits multiple CPUs and IOPs to reside on the same bus to provide increased performance when necessary. The computer configuration, includes a central processor unit (CPU), 4 Megabytes of solid state memory, and one IOP capable of handling direct memory access (DMA) transactions on 8 independent channels. The new Series 800 processor, based on reduced instruction set (RISC) architecture, delivers 4.5 MIP performance while retaining software compatibility with the previous generation processors.

Mass storage is provided by fixed or removeable media disk drives. The Hewlett-Packard 7900 series drives combine Winchester technology, a separate HP 9144 cartridge tape drive supplying cost effective backup and user I/O, and a sophisticated microprocessor-based controller to manage both storage components, all integrated into a single compact package. A 16 ms. average access time and a data transfer rate of up to 1 Megabyte per second make these drives among the highest performing mass storage devices available.

The Metheus Omega 3610 display controller is used to drive the color CRT display. The controller memory is configured to hold 1024X1280X32-bit images. These are displayed at 60 Hz non-interlaced refresh rate using bright color monitors. The custom bit-slice processor contained in the Omega 3610, with a cycle time of 167 nanoseconds, can flash-fill rectangles at 160 million pixels per second.

The display controller communicates with the HP 9000 via a 16-bit parallel interface, using a simple byte-oriented protocol. The command structure minimizes the the number of bytes which must be transferred from the host to perform time-critical tasks. A comprehensive instruction set (Table 1.) simplifies the design of host computer software and contributes to efficient operation.

The programmable cursor allows any size cross-hair cursor to be specified. A set of 122 characters (8x16 pixels) is resident in ROM and is loaded into a special character RAM at power up. Space is provided for asecond character set as well. Either character set may be chosen by the user. Instructions are provided for scaling character size and specifying character spacing.

Software

The HP-UX Operating system, a licensed and supported version of AT&T's System V, provides a productive environment for the development and execution of image processing software. Programmers andusers may easily share and reuse files and tools without sacrificing system security and reliability. The HP-UX operating system features multi-user capability, multitasking capability, virtual memory for code and data, and engineering tools such as data base management and data communications.

The workstation provides the Global Applications Executive, which standardizes the link between the user and applications programs under the UNIX operating system,. The user can operate the system in three modes. In the menu mode, the user is asked to make a selection from a list of menus and applications. In the command mode, the user communicates with the system via simple English-like commands. Finally, in tutor mode, the user is prompted for all parameters which must be supplied to a program. In both the command and tutor modes, the applications executive checks that all parameters entered by the user lie within the correct range. In command mode, if any parameter lies outside a valid range, the user is asked to re-enter the command; in tutor mode, he is re-prompted for the parameter. Parameters may be optional or mandatory. Optional parameters not specified by the user are assigned default values by the executive. Help files, which display information on the operation of the menu, command, and tutor mode as well as on the operation of all application functions, are available.

A Programmer's Subroutine Package was provided to accelerate applications software development. This package contains FORTRAN callable I/O routines for reading data from existing images as well as creating new images. Images created using this subroutine package are automatically cataloged and can contain any number of lines and samples with up to 64 bands. Image data can be any one of five types ranging from one byte per pixel, to 64-bit real values per pixel.

A sophisticated Graphics Software Package (GSP) has been written to support the Omega 500 Display Controller. At logon, the GSP assigns a display, if one is available to each user. The user can operate in one of three modes. In the first mode, the display is divided into four 8-bit image planes; in the second mode, three 8-bit image planes and one graphics overlays are enabled; and in the third mode, two 8-bit image planes and two graphics overlays are used. The GSP keeps track of the current display mode, active image and graphic overlay planes, and active monochrome or pseudocolor look-up tables. Up to 32 pseudocolor and 32 monochrome look-up tables can be stored and easily recalled.

The applications software includes programs to perform geometric correction, earth location. and registration of remotely sensed data. These programs handle imagery from the Advanced Very High Resolution Radiometer (AVHRR), the Coastal Zone Color Scanner (CZCS), the Multispectral Scanner (MSS), the Scanning Multichannel Microwave Radiometer (SMMR), and the Visual and Infrared Spin Scan Radiometer (VISSR). Other programs permit displaying monochrome and true-color images. Line graphics can be overlayed onto the displayed image in different colors. Interactive manipulation of these images is possible via a digital tablet provided. Interactive function include panning, histogram normalization and pseudocolor manipulation.